COMPARISON BETWEEN A FABRE GLOTTOGRAPH AND A PHOTO-ELECTRIC GLOTTOGRAPH

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1. Introduction.

In this article are published a few preliminary results from the test of our Fabre Glottograph and comparisons between our photo-electric glottograph and the Fabre Glottograph. Glottograms of most of the Danish consonants are compared with the airflow curves and the oscillograms, and the three-dimensional type of vocal cord oscillation is shown by comparing the curves from the two types of glottographs. *)

1.1. Airflow registration.

Some simultaneous recordings of the airflow (trace no.1), the electric impedance of glottis (trace no.2), the square area of the glottis (trace no.3), and the acoustic oscillogram (trace no.4) have been made for this article. The airflow recordings are made by means of the Electro Aerometer and show the outlet airflow measured in volume unit per time unit (cm^3/sec.), - the instrument can be exactly calibrated but has not been calibrated for the illustrations in this article. A raising of the airflow trace in the recordings means that the outlet airflow is increased.

1.2. Photo-electric glottogram.

The photo-electric glottogram shows the square area between the vocal cords in a horizontal plane. The photo-electric glottograms have a well defined zero level for closed glottis. However, the glottis may sometimes be closed though the zero level in the glottogram trace nas not been reached, this is because of a certain degree of transillumination of the closed glottis which can be observed especially in the head register.

With some subjects we have experienced trouble when inserting the plastic tube with the photo transistor (light

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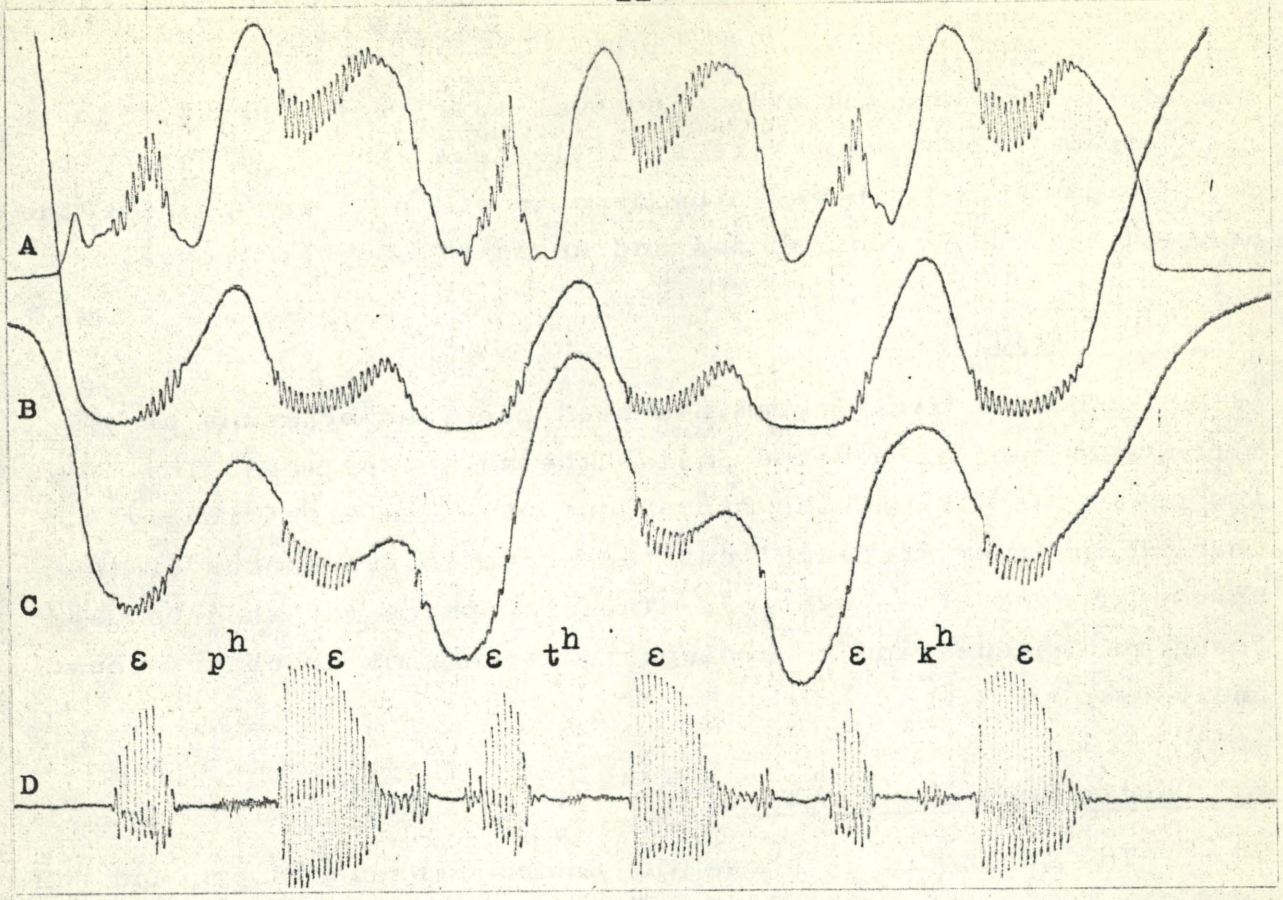
*) Both types of glottographs and the Electro Aerometer used for this article are manufactured for sale by B. Frøkjær-Jensen, Vestre Paradisvej 46, 2840 Holte, Denmark.

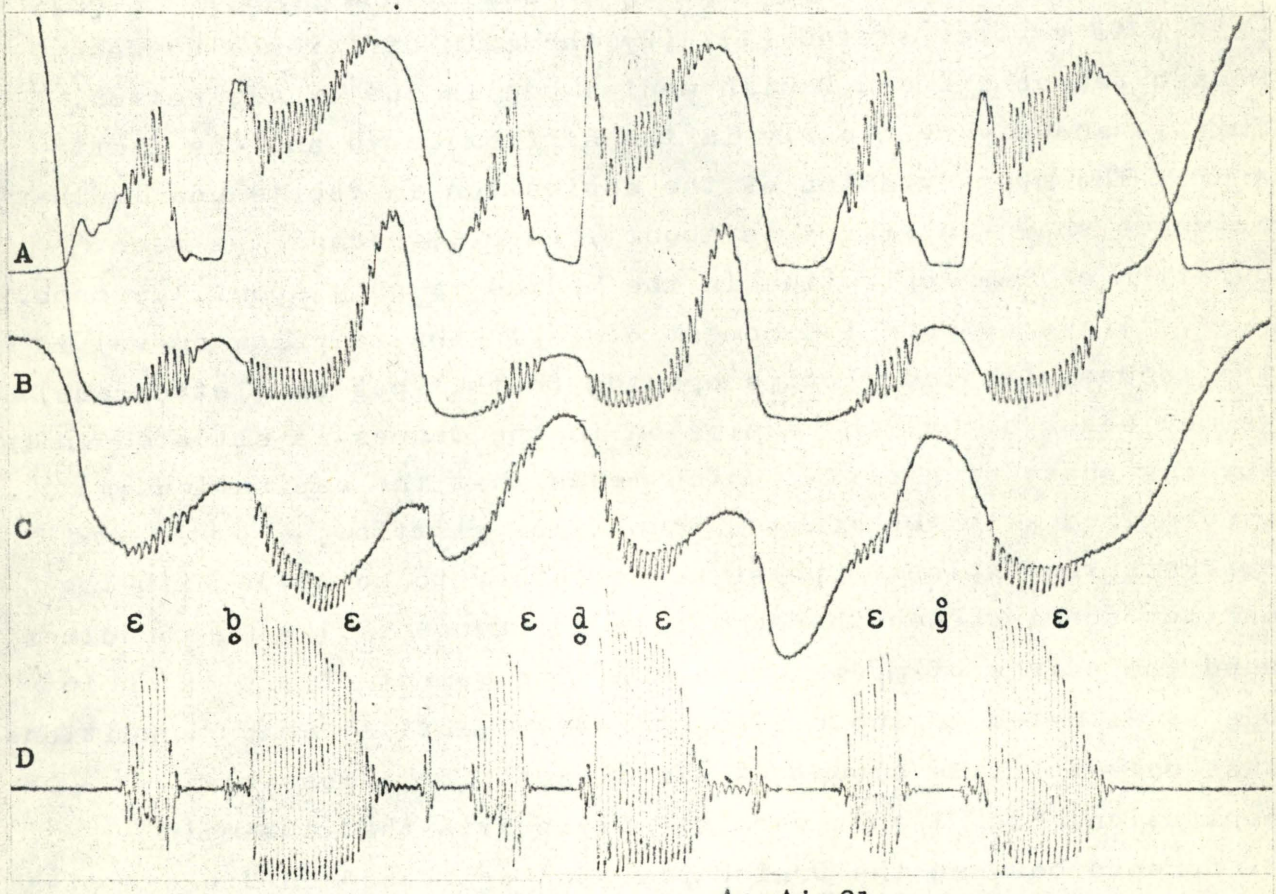
transducer) through the nose down into the pharynx. We have to a great extent overcome this problem by mounting the transducer in a 2 mm plastic tube and by glueing the free end of the transducer to the tube by means of liquid plastic mass. Furthermore, both a small lense in the end of the photo transistor and the black painting of the transistor has been removed. These improvements of the transducer makes it easier to insert it through the nostrils without much inconvenience. The transducer may be inserted in position in the pharynx and fixed outside the nose by means of a piece of court plaster. Thus fixed it can be used for hours without discomfort and without disturbing the articulation (no local anaesthesia is necessary). It is also possible to pick up the light in the pharynx without serious interference from the articulatory movements. Only when articulating the most open vowels [ɑ:] and [ɒ:] the back tongue and the epiglottis push the photo transistor out of position. These vowels can, therefore, normally not be recorded by the photo-electric glottograph.

1.3. The Fabre Glottograph.

The Fabre Glottograph shows the electric contact area between the vocal cords in a vertical plane. However, different articulatory movements of the pharynx and of the larynx may influence the electric impedance between the electrodes, as pointed out earlier (3). These undesirable physiological changes cause a very jumpy zero line which is difficult to stabilize in the registration range of the recorder. Our glottograph has therefore been provided with four different outputs, two of which have different time constants (25 msec. and 4 sec.) for stabilizing the zero line during articulation (6). (These outputs have not been provided for the glottograms shown in this article.)

Some few subjects seems to have a throat unfitted for electric impedance measurements because of too much fat which results in a bad signal-to-noise ratio. The same sort of noise disturbance of the glottograms may be observed if the electrical contact between the skin and the electrodes is insufficient. Therefore we always use electrically conducting jelly between





Speed: 100 mm/sec.

A: Airflow curve
B: Photo-electric glottogram
C: Fabre glottogram
D: Oscillogram

Fig. 1.

the electrodes and the skin. The oval electrodes used for the glottograms shown below were a little less than 2 cm^2 each, but further experiments have to be done in order to investigate the influence of different shapes and areas of the electrodes.

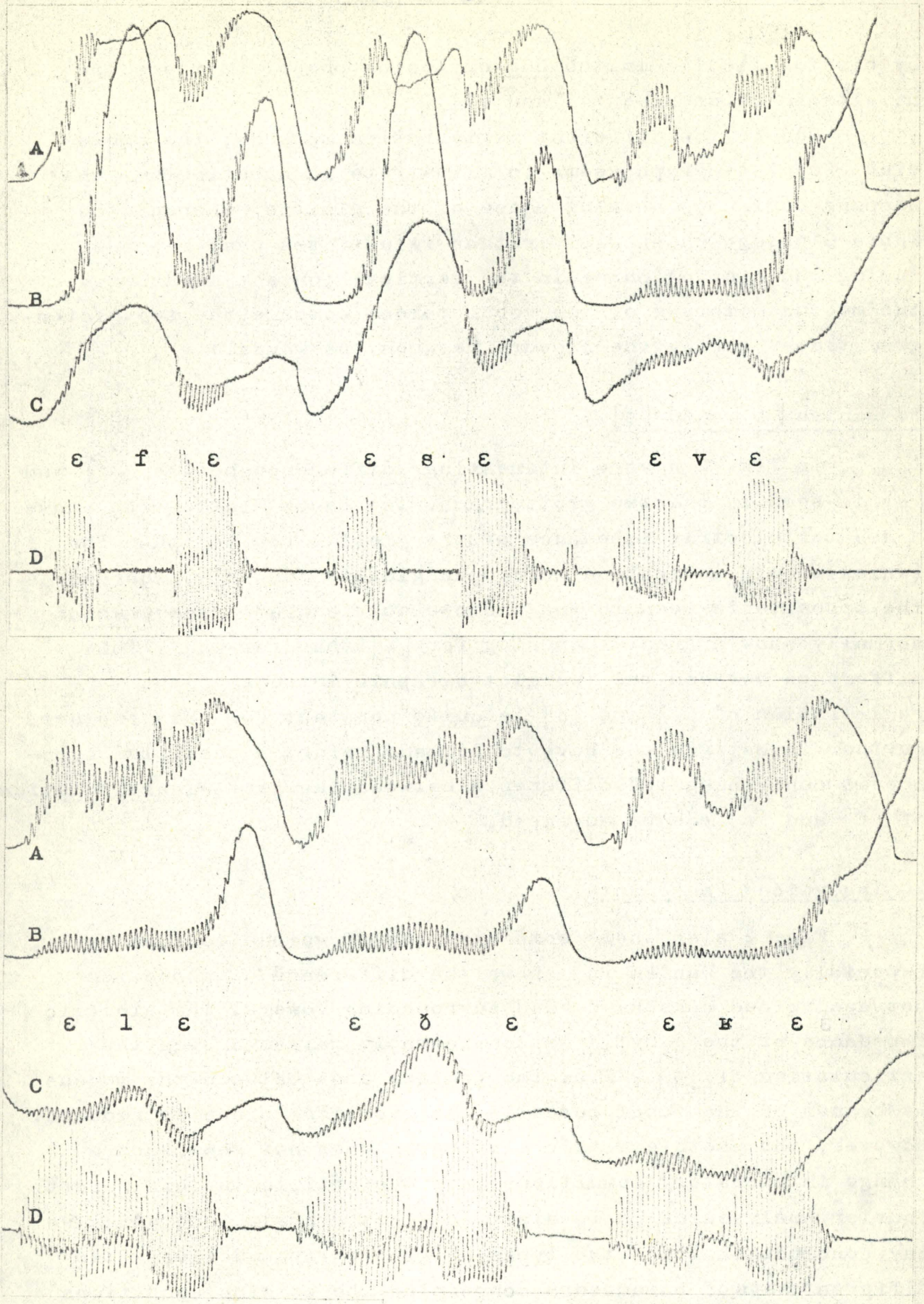
1.4. The oscillogram.

A normal oscillogram has been recorded by means of a microphone capsula mounted inside the aerometer mask. The frequency response of the microphone has been electrically changed in order to cancel out the acoustic resonances of the aerometer mask (tube system). The microphone may thus be used for simultaneous tape recordings for sonagrams or other acoustic analyses.

2. Danish tenues and mediae.

The table Fig. 1 shows the Danish consonants ptk and bdg in nonsense context: [ɛpɛ], [ɛtɛ] , [ɛkɛ] , and [ɛb̥ɛ], [ɛd̥ɛ], [ɛg̊ɛ]. As earlier stated (1), (2) the main difference between Danish tenues ptk and Danish mediae bdg is one of aspiration. This is shown very clearly in the airflow curve and the glottograms. The mean duration of the aspiration in the tenues in the examples shown in Fig. 1 is about 7 csec., whereas the mean duration of the aspiration in the mediae is only about 1.5 csec.

If we compare the moment of explosion (airflow curve) in the tenues with the glottis opening (both types of glottograms) we may observe that the explosion in the tenues is situated in the opening phase of glottis, which means that the aspiration is syncronized with the maximum opening of glottis. - With some speakers the explosion phase seems rather to coincide with the maximum opening, see the curves in reference (3). - On the other hand the curves of mediae show that the moment of explosion in bdg is situated in the closing phase of glottis, which conditions that only a little amount of air is left for a possible aspiration. Fig. 1 thus very clearly proves that the main difference between the Danish ptk and bdg (based on 256 examples for only one speaker BFJ) is one of opening glottis during the ptk-stop closure and fully open glottis during the ptk-aspiration versus medium open glottis during the bdg-stop closure followed



A: Airflow curve
B: Photo-electric glottogram
C: Fabre glottogram
D: Oscillogram

Speed: 100 mm/sec.

Fig. 2.

by closing glottis in the bdg-explosion phase. (Compare the results in references (4) and (7)).

Due to the different registration methods, the photo-electric glottograph seems to illustrate in a better way what happens during the opening phase of the glottis, whereas the Fabre Glottograph probably rather illustrates what happens during the closing phase in the vertical contact area between the mucous membrane of the vocal cords (compare the two glottogram traces during the closure between the words.)

3. Danish [f] and [s].

In Fig. 2 a very interesting difference between [f] and [s] is seen in the two glottograms. The Fabre Glottograph shows a greater electric impedance of the glottis for [s] than for [f] (which should indicate a more open glottis for [s]), whereas the opposite is seen in the photo-electric glottograms, which normally show a greater opening for [f] than for [s] . This difference between the two glottographic methods in the registration of [f] and [s] is quite constant for this subject. Further investigations have to be made before a possible hypothesis concerning the difference between the glottal articulations of [f] and [s] can be advanced.

4. The voiced consonants.

Fig. 2 also shows some examples of voiced consonants. Especially the Danish [ð] shows the difference of phonation between voiced consonants and surrounding vowels. The electric impedance of the glottis is considerably raised during the articulation of [ð] , i.e. the contact area between the mucous membranes of the vocal cords in the vertical plane is reduced. However, the photo-electric glottogram does not show such a change in phonatory conditions (see the article in this report: Fourier Analyses of Photo-electric Glottograms). Once again we may conclude that the two types of glottographs deliver two different sets of parameters concerning the working conditions of the human larynx.

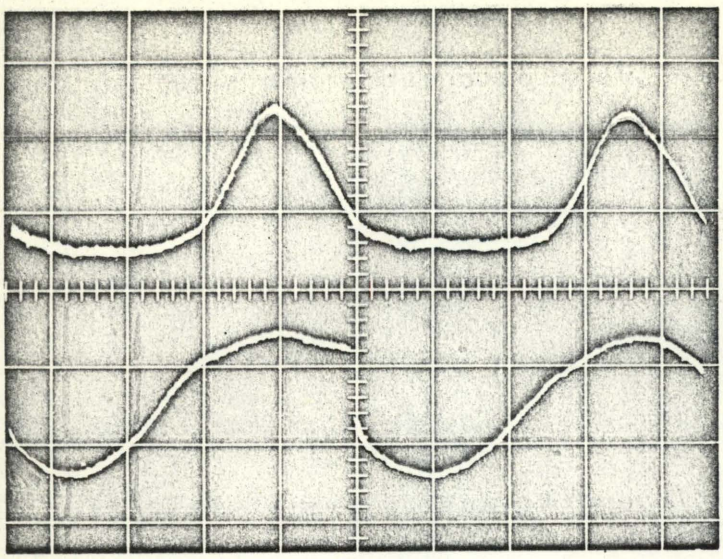


Photo-electric glottogram.

Fabre glottogram. (electric impedance)

Vowel[ɛ:], spoken by subject BFJ. Chest register, medium voice effort, fundamental frequency 120 cps.

Fig. 3.

5. Recordings of the primary voice source cycle.

Fig. 3 shows a polaroid photo of simultaneous recordings made by the two glottographs. The photo is a good illustration of how we can get information about the three-dimensional opening and closing movements of glottis.

If we compare the slope of the glottal cycle in the Fabre glottogram (the lower trace) with the photo-electric glottogram we can only explain the different forms of the two simultaneously recorded curves by assuming the explosions (excitations) as a slowly opening movement starting from below and moving upwards. When it reaches the edges the vocal cords open up and we get in the upper curve a registration of the opening area. When the glottis closes the Fabre glottogram shows that the two mucous membranes in the vertical plane suddenly come into touching contact with each other, i.e. we have a gradually opening and a suddenly closing movement.

This function of the primary voice is typical for the chest register (8), (9), which operates both in the vertical and the horizontal plane.

Recordings of the typical head register function do not show this three-dimensional type of oscillation.

Acknowledgement.

The construction of the two glottographs has been supported by "Statens Almindelige Videnskabsfond" (the Danish State Research Foundation).

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